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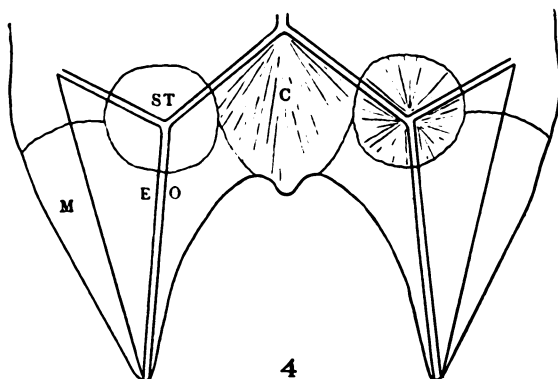
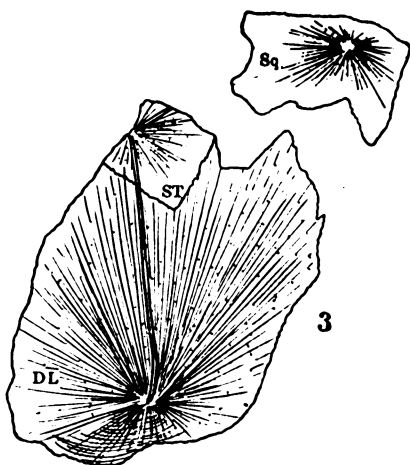
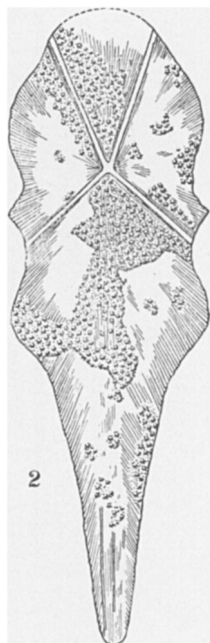
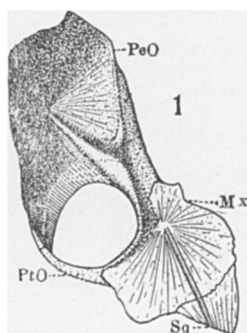
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PLATE XII.



ON THE CHARACTERS OF MACROPETALICHTHYS.

BY C. R. EASTMAN.

Although crania of *Macropetalichthys* have been known for more than sixty years, and have been frequently figured and described, the genus remains one of the most enigmatical of Palaeozoic fishes. Notwithstanding its abundance and generally excellent state of preservation, circumstances which are conducive toward a comparative investigation, we have as yet only a superficial knowledge of its structure. In fact, it would not be exaggerated to assert that none of our Devonian fishes have been so completely misapprehended and erroneously described as *Macropetalichthys*. This will hardly be disputed when we recall the disagreement concerning the number of species, and the fact that they have been described under no less than five different generic titles. It is further true that sensory canals have been almost invariably mistaken for sutures, and comparisons essayed on the basis of an imaginary osteology; a structure altogether distinct from the head shield, and separated from it by a bony wall, was mistaken for the "cerebral chamber" (Newberry); a pineal foramen is stated by all observers to be absent; and the osteology of the most familiar species, *M. sullivanti*, is still a *regio incognita*.

The only species in which the arrangement of cranial plates has been worked out with any degree of accuracy is that recognized as the type of the genus, *M. rapheidolabis*. The original description of this species by Norwood and Owen¹ is very imperfect. Newberry,² who examined a cast of the type specimen, elicited no new information regarding it; and it was reserved for Cope,³ as late as 1891, to redescribe the type specimen as satisfactorily as its mutilated condition would permit. This historic fossil, it is sad to relate, has since been destroyed by fire. Cope also described in the same article a specimen of *M.*

¹ Amer. Jour. Sci. [2], Vol. I, (1846), pp. 367-371.

² *Ibid*, Vol. XXXIV, (1862), p. 76.

³ Proc. U. S. Nat. Museum, Vol. XIV, (1891), pp. 449-456.

sullivanti, which was weathered in such a manner as to reveal the under surface of the head. Reference will hereafter be made to this description, which is in every way a notable one, and the cranium on which it was based. For an opportunity of studying the latter, together with other valuable specimens preserved in the museum of Ohio State University, the writer is greatly indebted to Dr. Edward Orton.

Besides these specimens, the writer has examined a large amount of material belonging to different public and private collections, and is thus enabled to supply certain deficiencies in our knowledge of the leading species *M. sullivanti*. Only a brief exposition of the cranial characters can be attempted within the limits of the present article, a more detailed discussion being reserved until another time.

The cranium of *Macropetalichthys* is to be conceived as a comparatively thin, flexible box or capsule, capable of withstanding a good deal of distortion without rupture. It is composed of plates united by squamosal sutures, and traversed centrally by the sensory canal system. The posterior boundary of the cranium is deeply concave in the middle, and its postero-lateral angles are produced backwards for a considerable distance, over-riding a structure called by Cope the "nuchal plate." The elements taking part in these cranial prolongations are probably homologous with the epiotic and marginal plates of other Coccoosteids; although no definite sutures have been observed between them, a marked depression occurs, extending from the extremity of the posterior angle forwards toward the centre of the squamosal plate, and this depression may represent the natural boundaries of the epiotic and marginal plates. This depressed line corresponds with the externo-lateral suture of Newberry's "parietal? plate," as represented in his diagram.⁴ The externo-lateral boundary of his so-called "squamosal" is only the outer margin of the cranial prolongations just described; their inner margins have not been previously shown, but are represented in Pl. XII, fig. 4.

⁴ Palaeozoic Fishes of North America, (Monograph U. S. Geol. Surv., Vol. XVI, 1889), p. 43.

Two facts furnish additional corroboration of the view that the posterior cranial angles are formed by plates homologous with the epiotic and marginal of other Coccosteids: first, the course of the sensory canal system, which traverses the center of the epiotic in a straight line backward until it emerges upon and penetrates into an element called by Cope the "nuchal plate;" and second, the reception of the postero-lateral angles of the cranium into a concavity on either side of the nuchal plate so that the latter becomes firmly articulated with the head shield. This mode of union between cranium and nuchal plate is, we believe, equivalent to the hinge-joint formed by the epiotic and antero-dorso-lateral in other Arthrodires. The logical conclusion of this view is that the "nuchal element" represents collectively the dorsal plates of the body, and is homologous with the dorso-median and dorso-laterals of other Coccosteid genera; hence it is more properly styled the *dorsal plate*.

The dorsal plate, as it will hereinafter be called, occurs as a distinct element immediately behind the cranium, from which it is partitioned off by a thin osseous membrane that forms a vertical wall in front, and slopes away under the posterior angles of the cranium on the sides. A thin layer of bony tissue covers the entire upper surface and also the posterior face, the latter corresponding to the cranial process in the Dinichthyids. The existence of this element was known to Newberry, who regarded it as a "cerebral chamber." Cope demonstrated the fallacy of this notion, and considered it as a prolongation of the median occipital region backward in order to protect the anterior part of the vertebral axis; and it was held that "such a structure would indicate the presence of a number of fixed vertebral elements, such as exists in the chimaeras, the rays and the sturgeons." This author correctly observes that there are "two angular elements on each side of the posterior region, which are also shown to be distinct. . . . One of these is wanting in the specimen, showing its junction with the median element is by a smooth squamosal suture."⁵ These angular elements he calls the "lateral nuchal plates;" but it

⁵ *Loc. cit.*, p. 453.

is patent from the specimen that they are only the posterior cranial angles, produced in the manner already described. One of them is preserved in its natural position, and the other, that belonging to the right side, has become dismembered and lost. The supposed "articular glenoid cavity, possibly for the condyle of a mandible," which is stated to be "one-half in the cranium and one-half in the nuchal element," pertains entirely to the head shield, and abuts directly against the cranial roof.

Turning now to the osteology of the back of the head, very peculiar conditions are encountered. The boundaries of the

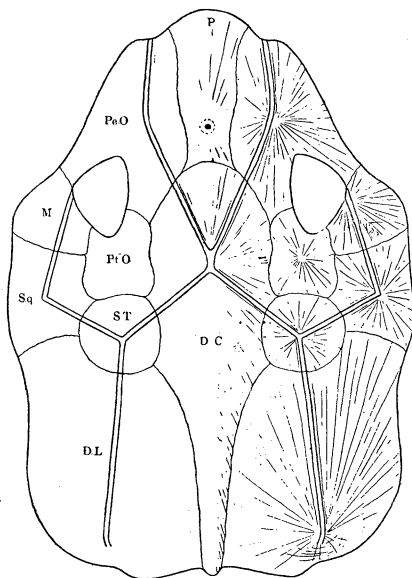


Fig. 5. *Macropetalichthys sullivanii* Newb. $\times \frac{1}{3}$.

large central plate are readily determinable, and are about the same as Cope has shown for *M. rapheidolabis*.⁶ Epiotic and marginal presumably constitute the postero-lateral angles. But superimposed upon the dorsal plate and hinder part of the cranium is a system of tuberculated derm plates which are arranged independently of the bones beneath. There is first of all a median superficial element which covers the same space as the central, but in addition to this it preserves its

⁶ *Loc. cit.*, pl. xxix, fig. 4.

continuity backward, gradually tapering as far as the hinder margin of the dorsal plate. That this is a coherent element by itself is proved by its occurrence in the detached condition; of several examples that have been met with, one is represented in Pl. XII, fig. 2. To distinguish it from other structures it may be called the *dorso-central*. On either side of the dorso-central is an apron-like expansion, which covers the remainder of the dorsal plate as far as its lateral margin, and incidentally conceals the posterior cranial angles. It is united with the dorso-central by sutures, and also with the plates in front of it in like manner. It, too, occurs in the detached condition, as is shown in fig. 3 (*DL*), and is worthy of being distinguished by a separate name. We propose to call it the *dorso-lateral*.

From the foregoing, it will be seen that portions of the cranium and also the dorsal element, to be regarded as a unit by itself, are covered by superficial scutes which are incapable of correlation with derm plates in other Arthrodires. Possibly they were originally coextensive with the underlying elements, which are now greatly reduced in thickness; afterwards they may have coalesced with one another and acquired a simpler, although still symmetrical arrangement. This condition is unparalleled among fishes, but a resemblance to it may be found in the corneous layer covering the carapace of turtles. The fact, however, that some of the tuberculated scutes no longer correspond with the subjacent elements, arouses a suspicion that the remaining scutes may present more or less modified conditions. It is to be noted that their arrangement differs from the pattern of most Arthrodires; but inasmuch as a separate system of plates has not been observed except in the posterior region, we may presume that in advance of this area each derm plate was covered by its own tuberculated coating.

The problem of determining homologies among the cranial plates is by no means an easy one. It is certain that the plate termed for convenience the "central" corresponds to much more than the like-named element in other Coccoosteids; in it are included at least the median occipital, the parietals and

frontals, as these are recognized in *Dinichthys*, and the inference is that fusion has taken place more or less extensively among the remaining plates. That the median series should consist of but two plates, central and pineal, appears quite remarkable. As names have already been applied to the system of paired plates by Cope, it appears advisable to retain them, not because all of them express undoubted homologies, but merely for convenience of distinction. If this author has delineated the boundaries of the maxillary plate correctly in *M. rapheidolabis*, we have here a marked difference between the type-species and *M. sullivanti*.

A small pineal foramen occurs at a point about half-way between the frontal lyra formed by the sensory canals and the extremity of the muzzle. Its position is indicated in the cranium figured by Newberry,⁷ although no significance was attributed to the structure there shown. The opening appears to be capped by a small operculum as in *Titanichthys*. Traces of a pineal foramen are also observable on a weathered specimen for which von Koenen⁸ has established a new genus, *Holopetalichthys*; but as the configuration of the cranium agrees essentially with that of *Macropetalichthys* (cf. fig. 4), and is from an equivalent horizon, we venture to regard *H. novaki* as pertaining to the latter genus.

A description of the osteology in detail, including the inferior structure of the cranium, is beyond the scope of the present paper. It is hoped, however, that the diagrams given herewith will suffice to show the general arrangement of the cranial bones as they appear on the dorsal surface. The writer desires in conclusion to acknowledge his especial indebtedness for the loan of specimens to the following persons: Dr. Edward Orton, Director of the Ohio Geological Survey; Prof. A. A. Wright, of Oberlin College; Prof. R. P. Whitfield, of the American Museum of Natural History; Prof. J. F. Kemp, of the Columbia School of Mines; Prof. C. H. Hitchcock, of Dartmouth College; and Mr. F. K. Mixer, Curator of the Buffalo Society of Natural Sciences.

Museum of Comparative Zoology, Cambridge, Mass.

⁷ Palaeozoic Fishes of North America (Monograph U. S. Geol. Surv., Vol. XVI, 1889), pl. xxxviii, fig. 1.

⁸ Abhandl. Göttingen Gesellsch. Wissen., Vol. XL, (1895), pl. iv, fig. 2.

EXPLANATION OF FIGURES.

PLATE XII.

- Fig. 1. Fragment showing plates surrounding the left orbit, seen from the inside. Original in the American Museum of Natural History, New York (Cat. No. $\frac{4261}{1}$). Corniferous limestone, Delaware, Ohio.
- Fig. 2. Detached dorso-central plate, from Lime Rock, Genesee County, New York. Original in Agassiz Museum, Cambridge, Mass. (M. C. Z., Cat. No. 1428).
- Fig. 3. Fragment showing three detached plates of the left side, seen from the visceral aspect. Original in Museum of Oberlin College (M. No. 10). Corniferous limestone, Sandusky, Ohio.
- Fig. 4. Diagram showing posterior cranial angles after removal of the dorsal ("nuchal") element and superjacent scutes.
- Fig. 5. Diagram showing arrangement of plates and course of sensory canals in *Macropetalichthys sullivanti*, $\times \frac{1}{3}$. Vascular canals indicated by radiating lines on the right side only (cf. Newberry's wood-cut, *Annals of Science*, 1852, No. 1, p. 12).

Plate figures reproduced two-thirds natural size. Sensory canals in figs. 1 and 3 are rendered more conspicuously than they appear on the specimens.

Lettering for all figures as follows :

<i>C</i> , Central.	<i>P</i> , Pineal.
<i>DC</i> , Dorso-central.	<i>PeO</i> , Preorbital.
<i>DL</i> , Dorso-lateral.	<i>PtO</i> , Postorbital.
<i>EO</i> , Epitotic.	<i>Sq</i> , Squamosal.
<i>M</i> , Marginal.	<i>St</i> , Supratemporal.
<i>Mx</i> , Maxillary ("malar" Cope; "suborbital" Newberry).	